INERTIAL CONFINEMENT FUSION

Lawrence Livermore National Laboratory

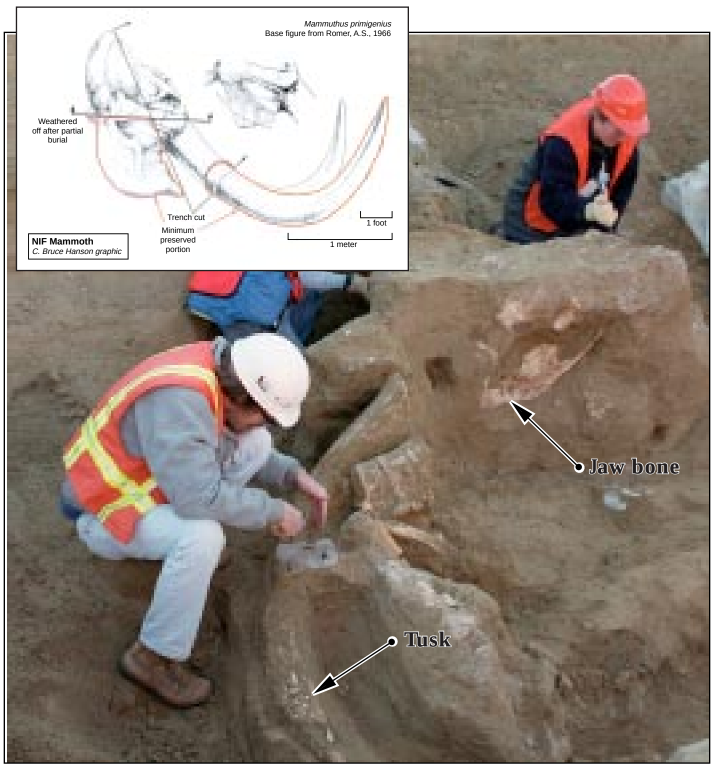
Monthly Highlights

January 1998

UCRL-TB-128550-98-4

NIF Mammoth Find Removed for Preservation.

More mammoth bones were found at the NIF construction site on January 12, 1998. Bones were first discovered on December 15, 1997, and the UC Museum of Paleontology curator visited the site the next day. Excavation began four days later, after approval by the Department of Interior. The find (see photo below), which includes a jaw bone (see inset), partial skull, tusks, some vertebrae, and ribs, all estimated at 10,000 years old, will go to the UC Museum, although the bones might eventually be borrowed for display in the NIF lobby.



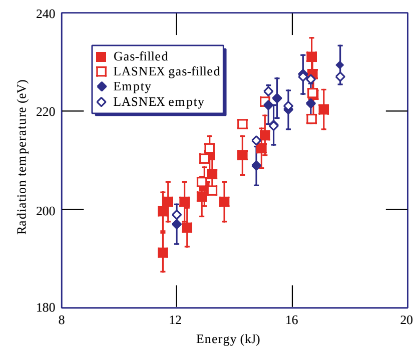
Workers carefully uncover 10,000-year-old mammoth bones. Inset: The outline shows exactly which parts of the skull were found.

Largest ($65.5 Million) NIF Subcontract Awarded.

The new contract, awarded to Hensel Phelps, covers build-out and finishing of the main laser building, not including the portion of the structure housing the laser fusion target chamber. Work will include mat and foundation slabs in two laser bays; installation of all interior walls and doors; heating, ventilating, and air-conditioning systems; plumbing and piping for water and other utilities; fire protection; power and communication ductbanks; complete electrical systems; central plant boilers and chillers; and site finishing work.

Nova Radiation Temperature Measurements.

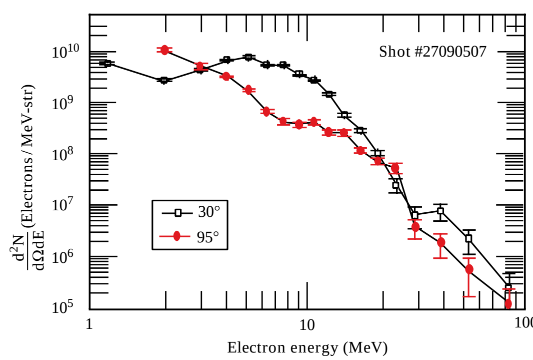
Beam-smoothing experiments performed with “NIF-like” shaped 2-ns laser pulses resulted in low laser scattering losses due to laser–plasma instabilities and improved coupling of the laser energy into the hohlraum. Under best smoothing (see figure below), we have found that more than 93–95% of the laser light was absorbed during the 1-ns high-power part of the laser pulse. We clearly observe higher radiation temperatures, exceeding 230 eV, with increasing absorbed laser energy. The radiation temperatures of both the gas-filled and the empty hohlraums are similar and compare well with detailed LASNEX computer calculations.



Temperature vs. absorbed energy between 0.8 and 1.8 ns of 2-ns pulse.

Petawatt Laser–Matter Experiments Begin.

We have begun a series of laser– matter experiments using the Nova Petawatt laser. The extreme brightness and short duration (~0.5 ps) of such laser sources offer a new tool for both basic science and time-resolved radiography of dense objects. We have obtained electron spectra extending to 100 MeV at $\sim 10^{20}$ W / cm^2 laser intensity on a 1-mm-thick gold target (see figure below). These high-current-density, energetic electrons will yield copious bremsstrahlung radiation as the electrons slow down in high-atomic-number targets. As such, these hard x-ray sources may offer an alternative to conventional sources presently used for stockpile stewardship radiography.



Electron spectra acquired at 30° and 95° with respect to the laser axis.

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Lawrence Livermore National Laboratory

Monthly Highlights

February 1998

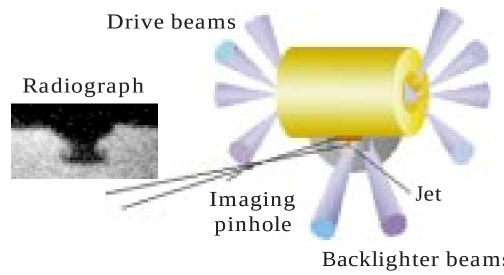
UCRL-TB-128550-98-5

NIF Construction through El Niño. NIF construction increased markedly in January and February as conventional facility construction crews began double shifts to compensate for the heavy rains in November and December 1997. Although the January rainfall was heavy, wet weather mitigation actions taken in December, such as mixing limestone into the topgrade soil to minimize water penetration, allowed work to progress without serious impact. Productivity is achieved immediately after heavy rainfall, and in some cases during a light rainfall or sudden cloud burst. Construction crews have adjusted to the wet weather, and the huge facility is quickly taking shape as shown below.

NIF Target Area retaining wall forms and rebar.

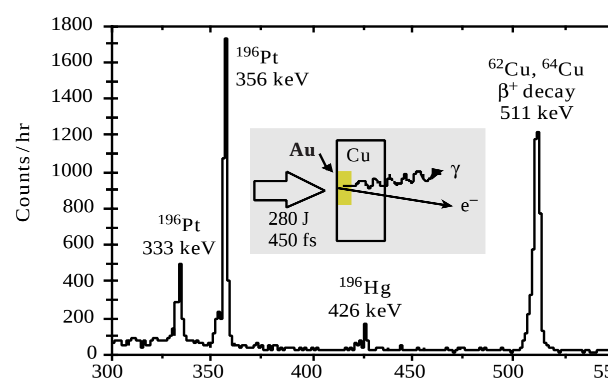
ICF Optics Area Subcontract Awarded. A construction subcontract, awarded to Dome Construction, covers conversion of the Nova Two-Beam facility into the ICF Optics Processing Development Area. Following the last Two-Beam experiment on November 12, 1997, the experimental equipment was disassembled and stored for future use. Optics processing will begin in late 1998.

Nova Experiments Emulate Supernovae. The use of high-energy-density physics experiments for laboratory astrophysics continues to draw considerable attention from university researchers. Recently, we obtained the first Nova radiographs of a 3D supernova-like feature. To examine the effects of such features, we developed a target in which the initial perturbation was a cylindrically symmetric dimple machined in copper. An equivalent 2D perturbation is a "ripple." When driven by a hohlraum, both perturbations invert and grow. The tip of the 3D jet grows significantly faster (i.e., has a higher tip velocity) than a 2D ripple of the same wavelength. Because of its symmetry, however, the jet (see radiograph below), unlike more complex 3D structures, can still be simulated with 2D astrophysical computer codes. These experiments are part of a collaboration with researchers from the University of Arizona, University of Colorado, and University of Michigan.



Radiograph (the black protrusion is the "jet") and experimental setup.

Petawatt Demonstrates Transmutation with a Laser-Produced Plasma. As part of a series of laser–matter experiments, the Petawatt laser has produced, in gold and copper targets, bremsstrahlung radiation (x rays from laser-accelerated electron / atom collisions, see insert in figure below) that exceeds the threshold for photon-induced nuclear reactions. The presence of photonuclear reactions, such as converting atomic weight ^{197}Au to ^{196}Au, indicates a large flux of bremsstrahlung photons above the threshold energy (8.06 MeV) for this photoneutron emission reaction. The production of ^{196}Au is clearly identified by the appearance of the nuclear de-excitation gamma rays in the ^{196}Pt (daughter nuclide of ^{196}Au) at 356 keV and 333 keV. In addition, the less probable beta-decay of ^{196}Au to ^{196}Hg is also identified by the line at 426 keV. A typical gamma-ray energy spectrum for an activated target is shown below.



Photoneutron activation of gold (Au) and copper (Cu) target material.

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INERTIAL CONFINEMENT FUSION
Lawrence Livermore National Laboratory

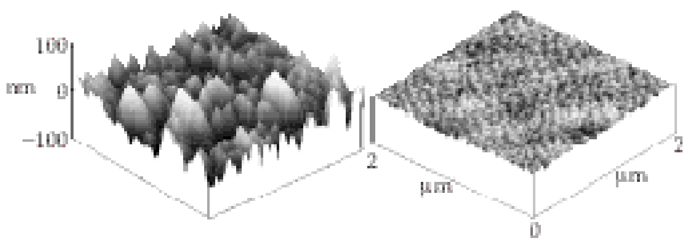
Monthly Highlights

March 1998

UCRL-TB-128550-98-6

Copper-Doped Beryllium for NIF Capsule.

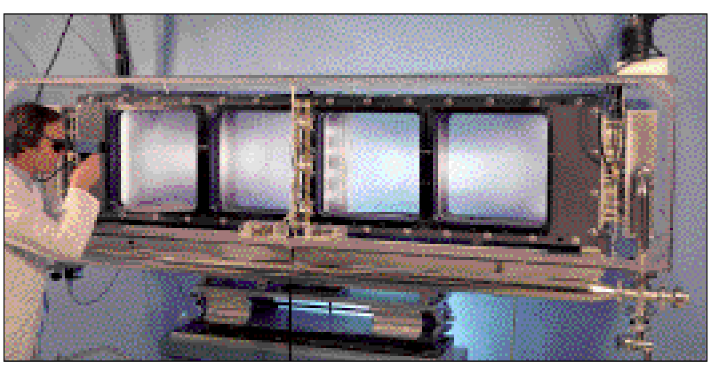
The ablator material for a NIF ignition capsule is important to the target performance. Copper-doped beryllium is one of several ablators being developed by a team from the Lasers and Chemistry & Materials Science Directorates. To improve the smoothness of our sputter-deposited beryllium (Be) films, we have been studying the effects of adding boron (B) to this capsule at various concentrations. Experiments on planar substrates have shown that at approximately 11 atom%B, there is a rapid decrease in grain size, resulting in a significant reduction of surface roughness. Below are two atomic-force-microscope (AFM) images of B-doped films, both ~5 microns (µm) thick. The image on the left is from a film containing 9 atom%B and has an RMS roughness of 19 nanometers (nm) over the 2-µm × 2-µm sample. The image on the right is from a film with 13 atom%B and has a roughness of only 2.5 nm RMS. A NIF Be capsule with total surface roughness less than 50 nm ignites in implosion computer simulations.



AFM images of Be at 9 atom%B (left) and 13 atom%B (right).

NIF Prototype PEPC.

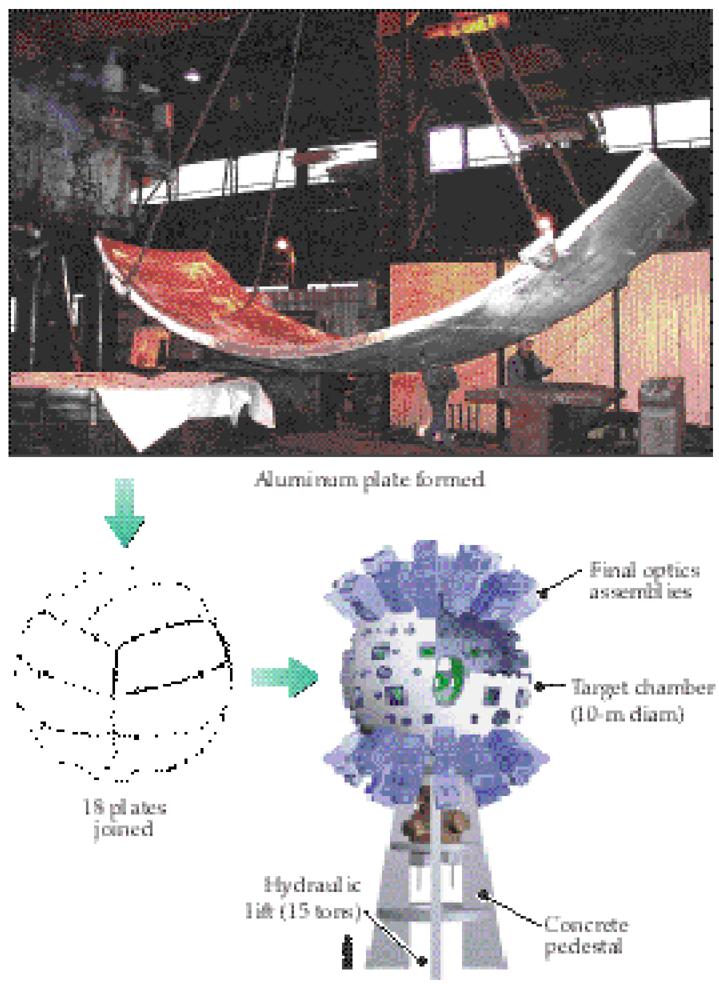
The plasma electrode Pockels cell (PEPC) allows polarization switching of laser beams through NIF-scale apertures, enabling the multipass amplification and parasitic oscillation suppression that the NIF laser design requires. We have developed the NIF PEPC in 4 × 1 line-replaceable units that fit into the NIF's 4 × 2 beamline bundles. The multi-aperture PEPC design is based on fundamental modeling, validation experiments, and cost optimization and is advanced far beyond the Beamlet design. The PEPC is still undergoing electro-optical testing, but initial tests indicate that it exceeds NIF design requirements.



The prototype 4 × 1 PEPC, shown horizontally, will be vertical on the NIF.

NIF Target Chamber Coming Together.

Fourteen of eighteen aluminum plates for the NIF's 10-meter target chamber have been formed. The aluminum plates, shown below, are hot-formed at 316°C in a 12,000-ton press. The plates will be shipped weekly in pairs to a shop under contract to Pitt-Desmoines Steel, where machining of weld joints on the first plate has already begun. The target chamber will eventually rest on a concrete pedestal, also shown.



18 aluminum plates join to form the spherical NIFtarget chamber.

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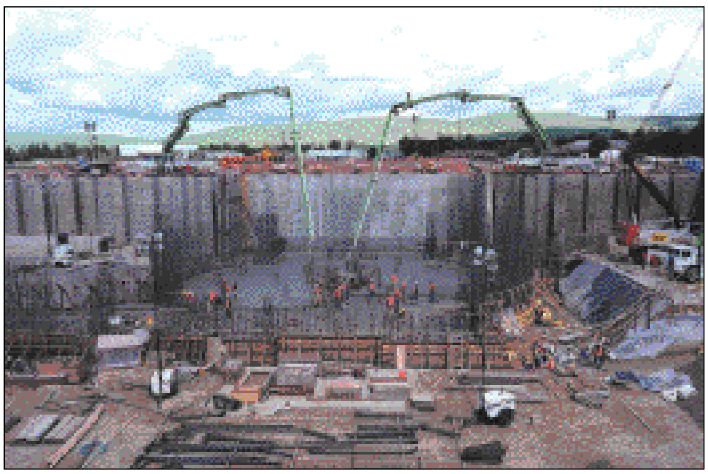
Monthly Highlights

April 1998

UCRL-TB-128550-98-7

Final NIF Conventional Facility Construction Contract Awarded. The last of the seven major Conventional Facility construction contracts, which total $157 million, was awarded at $58.4 million in late March to Nielson Dillingham; the notice to proceed was given April 13. Bidding and awarding of NIF construction contracts were divided into seven major (and one minor) bid packages covering all phases of construction. This final contract covers the portion of the facility that will house the target chamber, final optics, and laser switchyards. The photo below, available on a new Web page tracking NIF construction progress (http://lasers.llnl.gov/lasers/nif/building), shows an example of April activities.

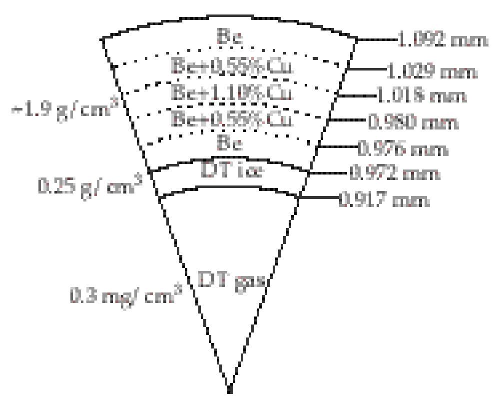


Pumping concrete for the 6-foot-thick target bay mat slab.

NIF Laser Glass Production on Schedule. The NIF Project is working with two laser-glass vendors, Schott Optical Glass and Hoya Corporation, to produce the laser glass used for the amplifier slabs. Initial results from the Schott full-scale melting run indicate that neodymium doping will succeed at full scale. The glass passed the NIF specifications for platinum inclusions and dissolved platinum, and also met the 1-µm absorption specification. Some of the glass will be fine-annealed over the next several weeks to evaluate homogeneity. The photo below shows a Schott NIF laser glass blank produced by continuous melting. Hoya's last demonstration meets most NIF specifications. All fabrication, inspection, and annealing ovens are included in one contract.

Schott Optical Glass and Hoya Corporation are developing NIF laser glass. Pictured is a full-size laser glass blank from Schott's continuous melter.

NIF Ignition Capsule Design at Below-Nominal Drive Conditions. We have designed a NIF ignition capsule to operate at both low-peak x-ray drive temperature (250 eV) and low total laser energy (900 kJ), simultaneously. This capsule ignites at these drive conditions, which are significantly less than the NIF point design (300 eV and 1.8 MJ) but is hydrodynamically less stable than the point design capsule. The 900-kJ capsule design, shown at right in schematic form, uses a beryllium (Be) ablator with a radially varying concentration of copper (Cu) to shield the fuel from radiation preheat and minimize hydrodynamic instability at the ice-Be interface. A 2D implosion simulation with 0.5-µm total rms multimode perturbation on the deuterium–tritium (DT) ice surface and a 15-nm total rms multimode perturbation on the ablator surface predicts ignition and propagated burn, yielding 3 MJ of fusion energy. Although these roughness specifications are beyond present capabilities, work is on going to improve ablator and ice surface smoothness.



BeCu NIF capsule proposed for reduced laser drive. (Not to scale; copper dopant levels are atomic percent.)

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Monthly Highlights

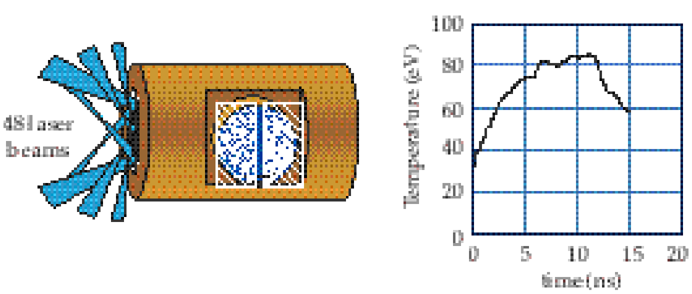
May 1998

UCRL-TB-128550-98-8

NIF Structural Steel Goes Up. As NIF construction continues, the steel framework erection has begun at the target area end of the building (see photo below); this work is being done by Nielson Dillingham, Inc. Meanwhile, all 18 of the target chamber plates have been formed and await final machining at Precision Components Corporation in Pennsylvania; the chamber will be installed in March 1999.

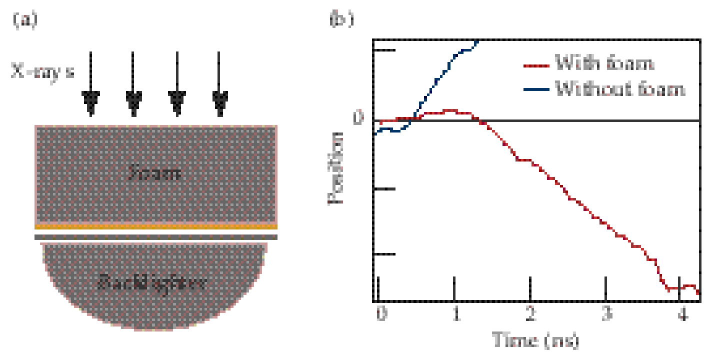
Steel erection begins around the NIF target area.

Omega Validation Studies Completed. A series of high-energy-density science validation experiments was recently completed on the Omega laser at the Laboratory for Laser Energetics in Rochester, New York. These experiments utilized the Omega laser in new and unique ways for stockpile stewardship activities. In one experiment, the laser was modified to provide 6 sets of laser beams sequentially delayed by 2 ns to provide a 12-ns pulse. These were used to create a hohlraum radiation temperature of ~80 eV to drive a supersonic radiation front in a low-density foam. Soft-x-ray opacity measurements required a time and spatially resolving spectrometer to be adapted and fielded on Omega for the first time.



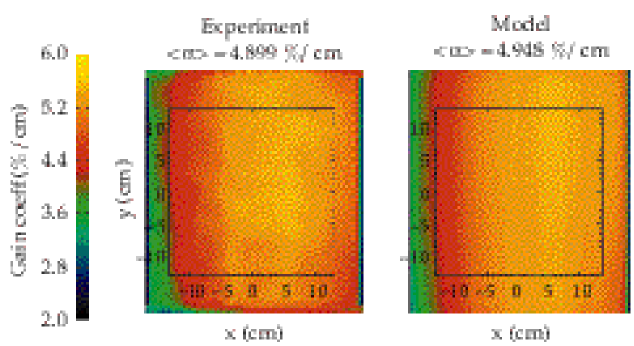
Low-density foam temperature in hohlraum.

Pressurized Foam Expands Experimental Capability. We have developed a new source for studying the hydrodynamics of compressible materials. These new experiments accelerate matter using material pressure generated by a "pressurized" foam. X rays from a hohlraum heat the foam shocklessly via a supersonic radiation wave [see (a) below]. The hot foam provides a pressure of ~20 Mbar, which can be used for a variety of experiments. For example a plastic package overcoated with gold has been driven both with and without the foam [see (b) below]; the gold expands in the case without the foam, and is driven downwards in the case with the foam, demonstrating the effect.



(a) Supersonic x-radiation wave heats the foam; (b) experimental results.

AMPLAB Gain Measurements. Gain measurements have recently been completed in the amplifier module prototype laboratory (AMPLAB) in full collaboration with the French CEA, who provided both hardware and scientific support. The prototype amplifier is similar to those planned for NIF. Gain distributions, shown below, are measured over the entire 40-cm-square apertures and agree with predictions based on a detailed 3D ray-trace code. The aperture-average gain coefficient for the beamline is 5.1%/cm, exceeding the NIF requirement of 5.0%/cm.



Results of AMPLAB gain measurements ("experiment") vs NIF beamline prediction ("model"); agreement is very close.

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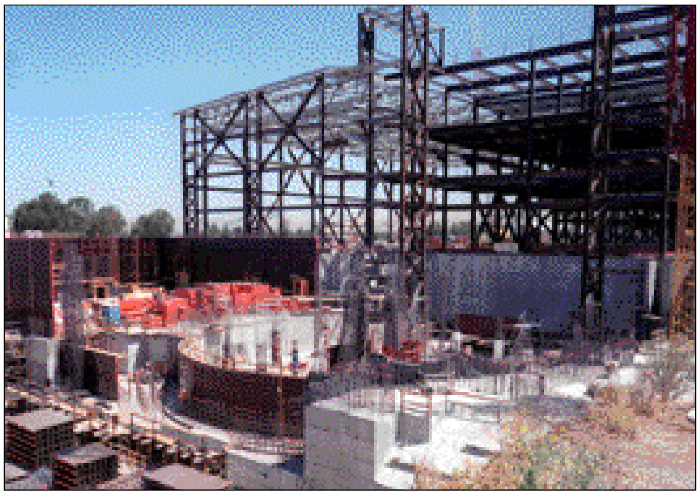
June 1998

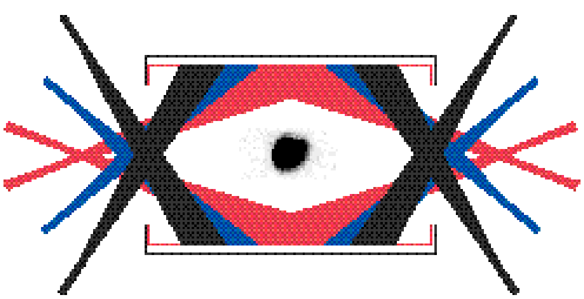
UCRL-TB-128550-98-9

NIF Steel Erected for Laser Bay 2. The Laser Bay 2 steel framework is now 75% installed. The structural steel in the core area of the laser building is completed, and installation of the metal decking in the core area has begun. In the target building, forming for the target bay walls in Switchyard 2 and in the target chamber area is currently being placed.



Laser Bay 2 structural steel erection behind the target area building.

Omega Hohlraums with NIF-Like Beam Geometry Produce Symmetric Implosions. In April, a successful 27-shot week at the Omega laser facility at the Laboratory for Laser Energetics in Rochester, New York, was performed, studying hohlraum x-ray drive symmetry using a 1:5 contrast-shaped laser pulse and a NIF-like multi-cone geometry. Diagnostic techniques included high-magnification (21.5×) x-ray imaging of the imploded core and x-ray backlighting of actual and surrogate targets ("foam ball"). These showed low-order Legendre harmonics asymmetries (P_2,P_4) to be small, with minimal time variation as predicted by simulations (foam-ball-derived values for a_2, a_4, <2 μm).

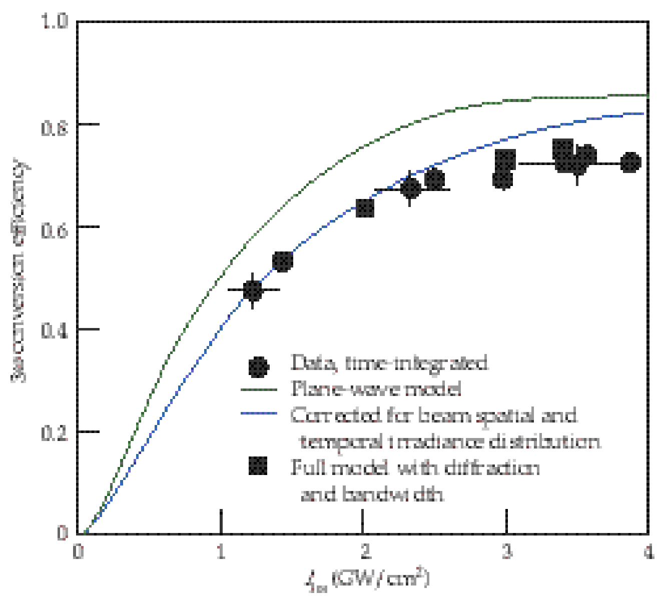


Omega hohlraum with NIF-like beam geometry, with a superimposed and magnified image of an imploded core after 20× convergence.

Neutron yields and neutron-based ρ*R* measurements were obtained from implosions with radial convergences of up to 17×. The results demonstrate the use of multiple beams to improve hohlraum drive symmetry.

Papers Presented at SSLAC. The Third International Conference on Solid State Lasers for Application to Inertial Confinement Fusion, cosponsored by the U.S. DOE and the French CEA, was held in June in Monterey, California. The conference had about 220 attendees from five other countries and the U.S., and 175 papers were presented. A fourthconference is currently planned to be held in Bordeaux, France, in late 1999.

Efficient 3ω Conversion with Rapidly Grown Crystals. Beamlet tests have successfully demonstrated efficient frequency conversion to the third-harmonic (3ω) wavelength of Nd:glass using rapidly grown potassium dihydrogen phosphate (KDP) crystals under a CEA / DOE collaboration. NIF-sized crystals (approximately 40 × 40 × 1 cm) are now being produced from boules grown rapidly over 6 to 8 weeks, compared to conventional growth methods that take over one year. The type I second-harmonic generator and type-II third-harmonic generator crystals needed for the Beamlet tests were machined from LLNL boules at Cleveland Crystals, Inc. Maximum extrinsic energy conversion to the third harmonic of 73.5% with an estimated peak-power conversion of 78% was obtained at an amplifier output irradiance of 3.6 GW / cm^2 in a 1.5-ns pulse, in agreement with detailed predictions.



Measured and calculated 3ω conversion efficiency plotted versus 1ω irradiance of the incident laser pulse.

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July 1998

UCRL-TB-128550-98-10

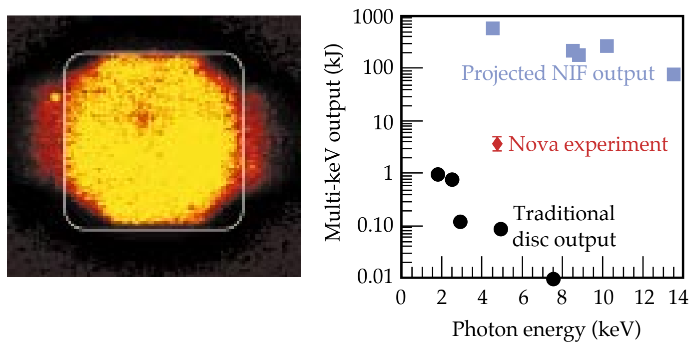
NIF Construction Moves Forward. Steel work for Laser Bay 2 and Capacitor Bay 4 has been completed, and work has started for Laser Bay 1. Work has also begun on the siding. The entire construction site is shown below.

Aerial view of the NIF site on 7/14/98.

Beamlet Closing Down. Beamlet performed its last experiment on July 31, 1998, following four years of laser science experiments in support of the NIF laser design. As a full-scale scientific prototype of the NIF laser, Beamlet was operated to full NIF design fluences and pulse shapes. Beamlet results changed and/or validated virtually all aspects of the NIF design. The experiments performed on Beamlet have been critical for proving that NIF will perform as predicted when activated in FY01, and the experiments were invaluable for benchmarking modeling codes and setting NIF optical finishing specifications. Disassembly of Beamlet will start August 1 and be complete by October 1, after which the space will be converted to support lab space that initially will be used for NIF amplifier assembly.

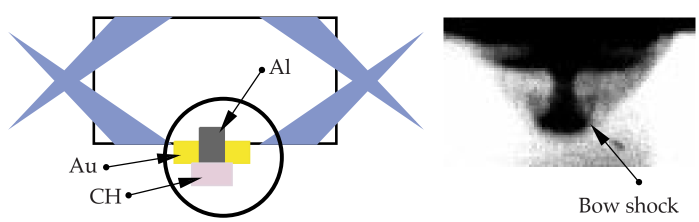
The Beamlet laser has been operating since 1994.

Multi-keV X-Ray Source Demonstration. A recent series of Nova experiments demonstrated that lasers can produce multi-keV x rays with significantly higher efficiencies than previously observed. These proof-of-principle experiments (performed as part of a collaboration with the Department of Defense, the Naval Research Laboratory, and government contractors) use Be hohlraums filled with a mixture of Xe and Kr gas. These novel sources converted laser light into x rays of photon energies >4 keV at an efficiency of 7 to 12%, more than 10 times the efficiency of traditional disk targets. The figure below shows nearly uniform 5-keV x-ray emission and that the energy output was significantly greater than we would expect from a traditional disk irradiated by the same laser energy. Computer simulations project that NIF can produce many hundreds of kilojoules of multi-keV x rays with similar targets, opening a variety of new applications.



5-keV x-ray emission (left) with graph of energy ouput (right).

Supersonic Jets. Experiments measuring the generation and propagation of supersonic jets (about Mach 8) were performed on Nova as a collaboration between AWE, LLNL, and LANL in support of Stockpile Stewardship. In the experiments, a Nova hohlraum generates an ablation front shock in a cylindrical Al target (see figure below). The shock propagates through the Al and breaks out its back surface, resulting in a jet at the Al–plastic interface. The jet is radiographed using a Ti backlighter laser pulse and pinhole imaged onto film. Kelvin–Helmholtz rollover at the tip of the jet is evident, and the proximity of the bow shock to the jet tip is evidence of the jet's high Mach number.



Laser pulse enters Nova hohlraum (left); jet propagates out from hohlraum (right).

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Monthly Highlights

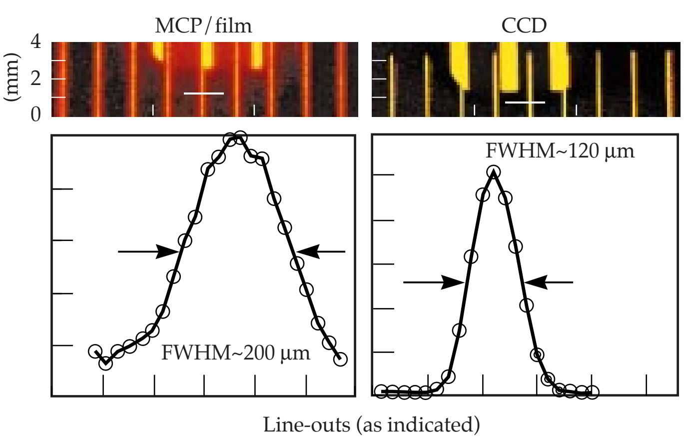
August 1998

UCRL-TB-128550-98-11

NIF Steel Framework up. The steel framework of the NIF is virtually complete. In recognition of this, the steel erection contractor Nelson Dillingham hosted the "topping out" ceremony, including a luncheon for over 225 workers and the placing of an American flag on top of the structure. More steel will be needed after installation of equipment into the laser bays. About 5,100 tons of structural steel have been used, and, by completion, the structure will contain 7,600 tons of rebar.

View of NIF construction looking east.

X-Ray Streak Cameras without Intensifiers. A prototype of the next-generation x-ray streak camera for use on Nova and ultimately on the NIF has been developed and tested. The device is comprised of a generic high-magnification commercial streak camera tube and cooled CCD. Streak camera electrons bombard the CCD, producing as many as 3,500 secondary electrons, which are easily detectable. First experimental results show significantly improved spatial resolution (see figure), better signal-to-noise ratio, and higher dynamic range.

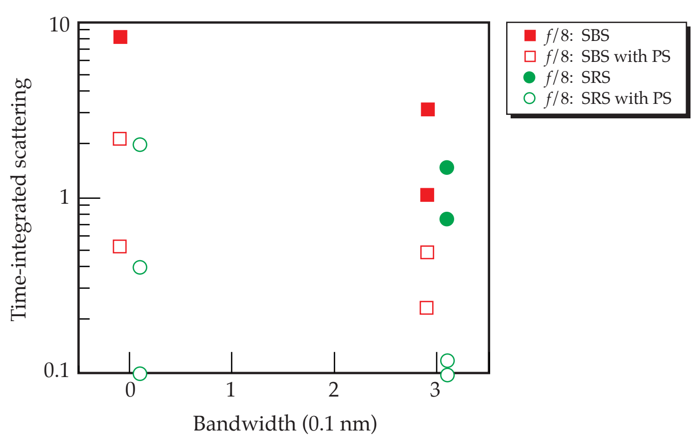


The FWHM decrease (right) shows improved spatial resolution.

PAM Prototype Meets NIF Energy Requirement. A fully integrated NIF preamplifier module (PAM) prototype has exceeded NIF output-energy requirements. We extracted 29 J from the multipass amplifier, exceeding the 22-J requirement. We are now diagnosing the PAM output wavefront and beam quality with a high-resolution diagnostic package. The PAM prototype is packaged as a NIF line-replaceable unit.

A mechanical technician adjusts spatial-filter telescopes in the PAM prototype.

NIF-Like Beam Smoothing Experiments. Recent Nova experiments showed that NIF-like smoothing by spectral dispersion (SSD) reduces scattering losses from gas-filled hohlraums. Stimulated Brillouin scattering (SBS) levels, shown below, are reduced when 0.3 nm of bandwidth using a 17-GHz modulator is added to an *f*/8 beam. Qualitatively similar results have been obtained with a lower-frequency modulator. A beam with the higher-frequency modulator more easily propogates through the NIF laser. Polarization smoothing (PS), first developed at the University of Rochester, further reduces the scattering levels, showing that it may provide more margin for NIF target performance.



SBS and SRS scattering from gas-filled hohlraums.

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Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

INERTIAL CONFINEMENT FUSION

Lawrence Livermore National Laboratory

Monthly Highlights

September 1998

UCRL-TB-128550-98-12

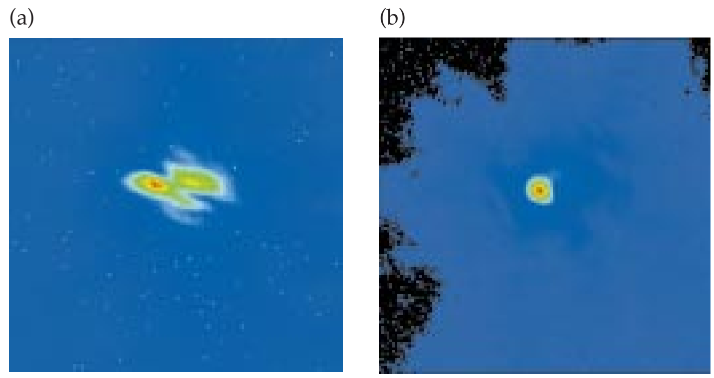
NIF Target Chamber Coming Together. The NIF target chamber assembly began this month inside the special Target Chamber Assembly Building. The target chamber, which is being constructed of 4-inch-thick aluminum, will be a sphere 30 feet across. It is being made of 18 plates that fit together in the same configuration as the panels on a volleyball; the photo below shows the first three panels joined into one piece.

The first three of 18 target chamber sections joined.

NIF Power Conditioning. Sandia National Laboratories in Albuquerque, New Mexico, has completed the assembly of the first article power conditioning module for the NIF. The first article module houses a maximum of 24 capacitors, storing nearly 2 MJ of energy to drive 40 flashlamps. The first article will be thoroughly tested over the next five months to ensure that the system design meets the NIF performance and lifetime requirements.

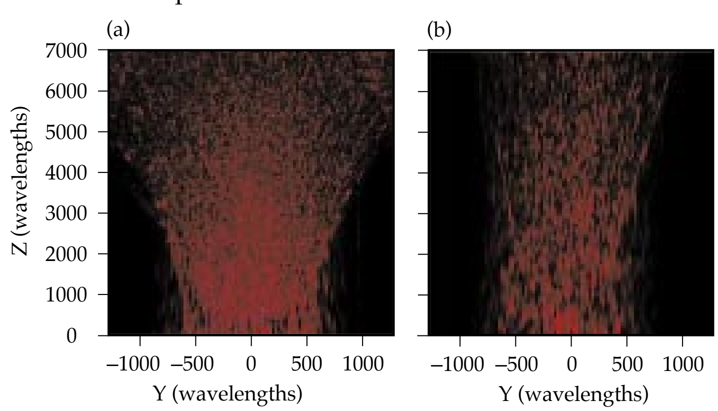
The first article power conditioning module for the NIF has been assembled.

Petawatt Laser Uses Deformable Mirror. The Petawatt laser at LLNL, already the most powerful single-pulse laser in the world, has been operated with an advanced wavefront control system, which has increased its peak focused intensity to more than 3×10^{20} W/cm^2. The new system is based on a deformable mirror (DM) similar to systems developed for AVLIS and NIF. Focal-plane images of the laser beam (shown below) illustrate the improvement afforded by the DM. The DM gives a smaller (8 μm at FWHM), reproducible, rather symmetric focal spot with approximately 30% of the laser energy contained within the central spot. This improved optical performance of the Petawatt laser allows scaling experiments to be extended to higher intensity.



Result (b) shows the dramatically smaller spot size of the Petawatt laser using a deformable mirror, leading to increased intensity.

Parallel Laser–Plasma Hydrocode (pF3D). A unique, massively parallel version of the laser–plasma hydrodynamics code F3D, called pF3D, greatly extends the simulation capability to plasma volumes approaching the size of an entire NIF beam (up to $56 \times 900 \times 2500$ µm). Simulations of filamentation with pF3D show that smoothing by spectral dispersion (SSD) controls beam spraying for NIF-relevant parameters.



pF3D simulation (a) with random phase plate only, and (b) with SSD.

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Monthly Highlights

October 1998

UCRL-TB-128550-99-1

Target Assembly Building Outer Wall Pour. The NIF Target Area Building's outer wall pour began with a 14-hour, 2,500-cubic-yard, monolithic pour on October 16 and 17. This section of the wall is 12 feet thick, and ranges from –21'9" to –4'6" (i.e., below ground level). This first major pour for the Target Area Building cylinder will be followed by additional pours, finishing at +86' (above ground level).

The first major Target Area Building outer-wall-cylinder monolithic pour is complete.

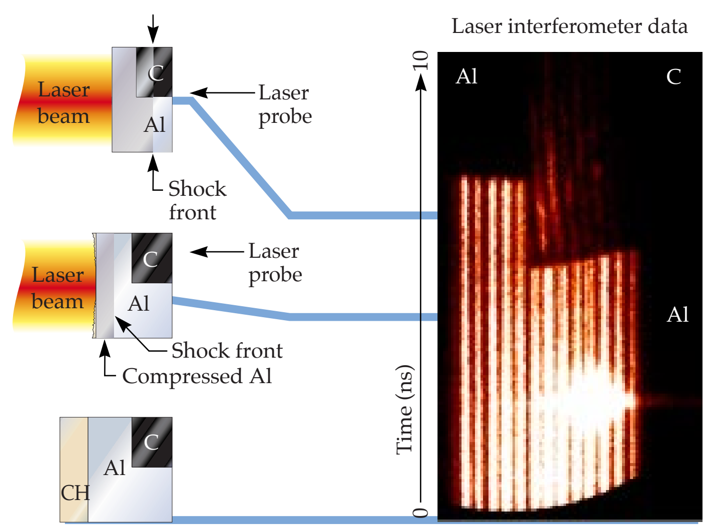
DKDP Growth Milestone. Large deuterated potassium dihydrogen phosphate (DKDP) crystal plates will be used on NIF to mix infrared and green laser light to the ultraviolet light needed for optimum capsule implosions. The first ever NIF-sized boule of DKDP, measuring 55 cm in each direction, was recently grown. This boule will yield about 17 conversion plates.

The NIF-sized DKDP crystal will yield about 17 conversion plates.

Beamlet Laser. The Beamlet laser has been removed from the LLNL high bay in Bldg. 381 and shipped to Sandia, Albuquerque, for use as a laser backlighter on their Z accelerator facility. The Bldg. 381 high bay is now ready for renovation by Dome Construction Company. The first use will be for NIF amplifier frame assembly.

The Beamlet high bay is now ready for conversion.

Nova Experiments Show Diamond Phase Change. We use VISAR (velocity interferometer system for any reflector) to measure the single-shock equation of state (EOS) and shock-compressed reflectivity of diamond (C). As shown below, the target design is a stepped aluminum (Al) witness plate with a CH ablator and diamond glued onto a thin Al step. Also shown below is the VISAR signal. The bright vertical lines are VISAR fringes from the motionless Al. The weaker, shifted fringes are from the moving shock front in C as the diamond undergoes a phase change from insulator to metal. Similar phase changes have been observed in lithium fluoride.



Nova experiments show the insulator–metal transition on the Hugoniot of diamond.

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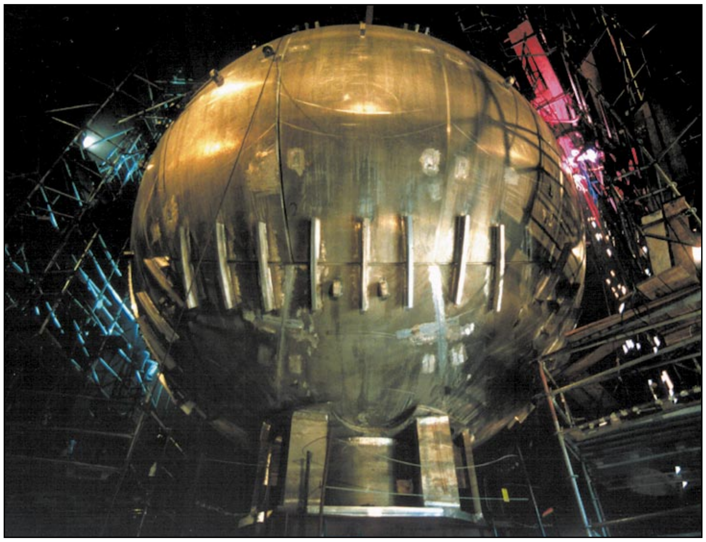
INERTIAL CONFINEMENT FUSION
Lawrence Livermore National Laboratory

Monthly Highlights

November 1998

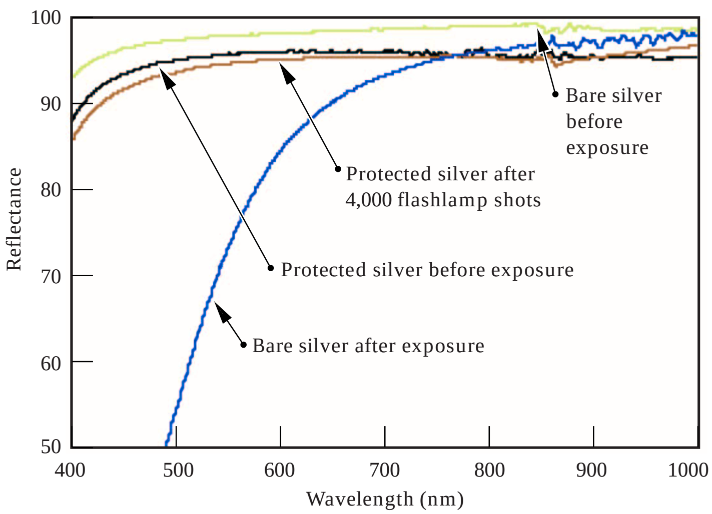
UCRL-TB-128550-99-2

NIF Target Chamber Welding Begun. The 18 plates of the NIF target chamber have been assembled and are ready for final welding. The chamber's aluminum walls are four inches thick and will have 118 diagnostic ports, 24 direct-drive ports, and 48 indirect-drive ports. The holes for these ports will be precision-drilled by Pitt-Des Moines, Inc., the contractor in charge of target chamber construction.



Welding has begun on the target chamber, which is 30 feet across.

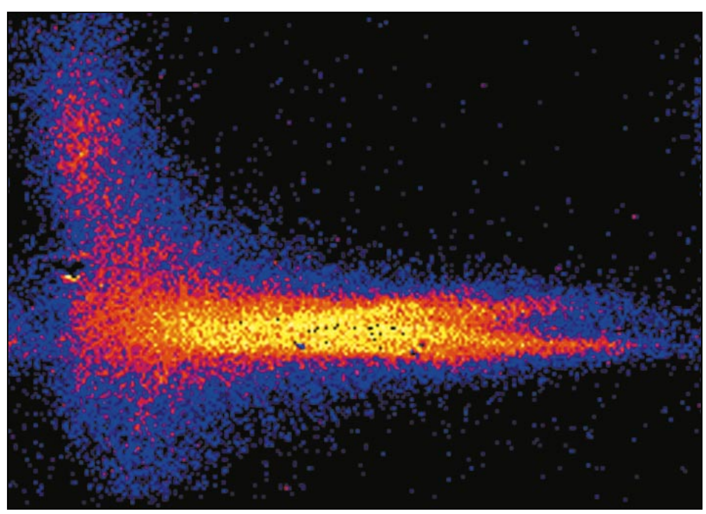
NIF Amplifier Coatings. NIF amplifiers will use an advanced thin-film coating on internal reflective surfaces consisting of sputtered, high-purity silver and a special protective overlayer. This coating preserves high-reflectivity surfaces for long periods of operation even in the presence of intense flashlamp light and typical airborne contaminants. These new protected reflectors will need to be replaced much less often than reflectors employed in current solid-state lasers, ensuring both higher performance and lower operating costs.



Tests on small samples show that the protected silver will retain its reflectivity much longer than bare silver in NIF.

Nova Experiments Win Award. Robert Cauble, Peter Celliers, Gilbert Collins, and Luiz Da Silva won the Excellence in Plasma Physics Research Award from the Division of Plasma Physics (DPP) of the American Physical Society (APS). The award given to them this month at the DPP meeting in New Orleans is for their work measuring the equation of state of hydrogen. Also at the meeting, the APS recognized as new fellows Luiz Da Silva, Guy Dimonte, and Gail Glendinning.

Radiative Supersonic Jets. Astrophysical jets, such as the well-known Herbig-Haro object HH47, have emerged as galactic laboratories for the study of radiative hydrodynamics. In collaboration with the University of Maryland, we are developing experiments on the Nova laser at LLNL and the Gekko laser at Osaka University, Japan, to study radiative jets. In the first of these experiments, we used five beams of Nova to directly drive the interior of a gold cone. The ablated gold plasma coalesces on axis to form a hot, radiative, high-velocity (~700 km/s) jet. The jet temperature is initially high (~1 keV), but quickly cools through radiative losses, resulting in a radiative collapse of the jet on axis. In simulations without these radiation effects, the jet remains hot much longer and its shape is more diffuse than in the fully radiative simulation.



Nova-produced radiative jet.

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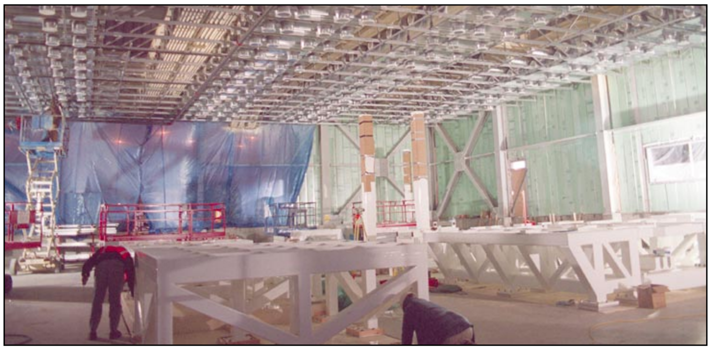
Lawrence Livermore National Laboratory

Monthly Highlights

December 1998

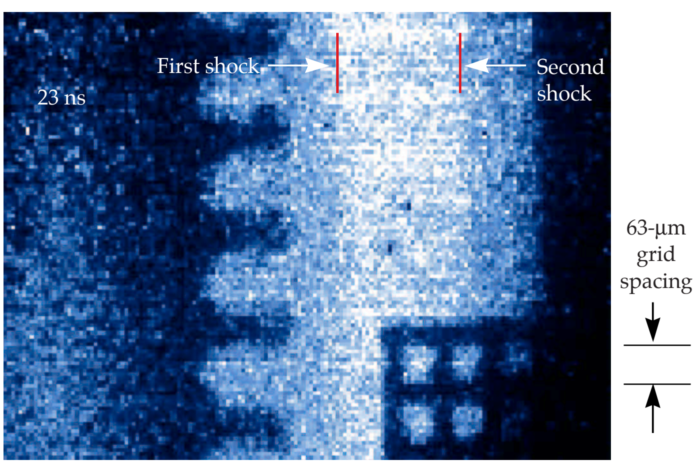
UCRL-TB-128550-99-3

NIF Optics Assembly Building Special Equipment Installed. The initial installation of Optics Assembly Building (OAB) Special Equipment was completed in November in parallel with ongoing construction. The OAB will be used for the clean assembly of optics and line-replaceable units. The equipment installed included the support structures for the assembly and alignment equipment, the two Laser Bay transporter vertical lifts, spatial filter tower vertical lift, and the clean-room jib cranes.



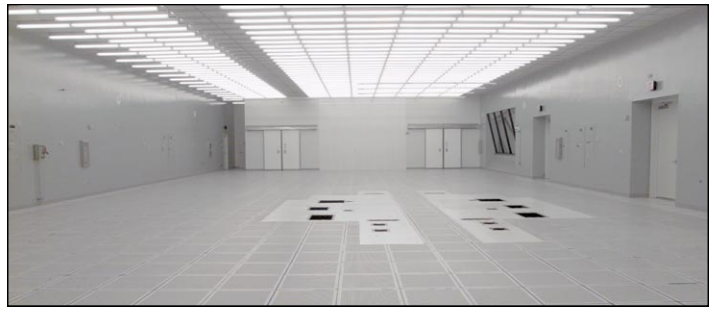
The initial NIF OAB special equipment has been installed.

A Novel Double-Shock Experiment on Nova. We have begun to investigate hydrodynamic instabilities in doubly shocked systems. A half-hohlraum driver launches a shock into a miniature shock tube across a rippled interface, causing the ripples to grow via the Richtmyer–Meshkov instability. A second, counterpropagating shock launched from the opposite end of the shock tube by a second half-hohlraum driver will impact the developing mix region. The figure below shows ripple growth after passage of the first shock. The second shock has not yet impacted the perturbed interface. Future experiments viewing later in time will observe the effect of the second, counterpropagating shock on instability growth.



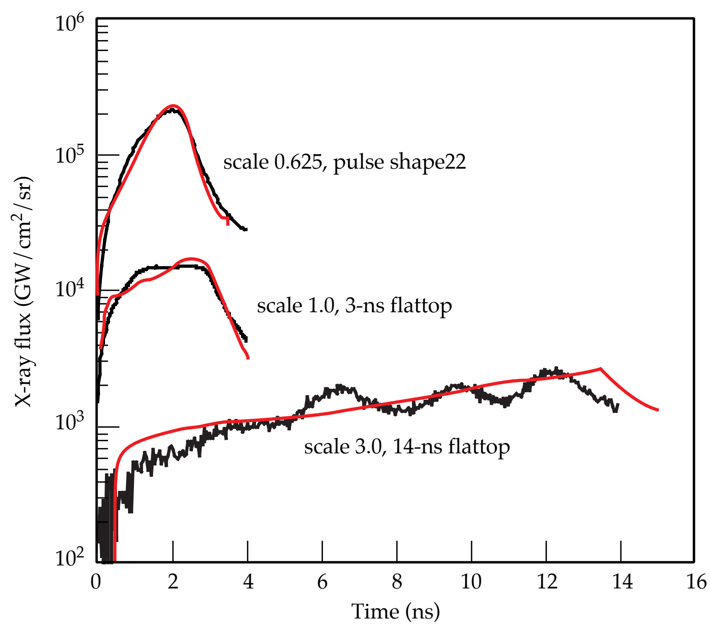
X-ray image from the 2SHOCK experiment at 23 ns.

Beneficial Occupancy of Optics Processing R&D Area. Construction of the first phase of the Optics Processing R&D Area (OPRDA) was completed in November. This clean room will house the precision cleaning and sol-gel antireflection-coating equipment for processing the NIF's large glass optics. These optics include laser glass, fused silica lenses and windows, and mirrors and polarizers.



The OPRDA is ready for occupancy.

X-Ray Drive Characterization. We have successfully predicted x-ray drive from Nova experiments in a variety of hohlraums. These experiments, some performed in collaboration with the French Atomic Energy Commission (CEA), produce varying drive conditions—from those in the initial low-intensity part to those approaching the high-intensity part of the NIF pulse. LASNEX has modeled the x-ray flux based on absorbed laser power to an accuracy of 4±12%, as shown in the figure, giving us confidence in our predictions for ignition drive conditions for the NIF.



Experimental (black) and simulated (red) x-ray flux from the hohlraum wall in three extreme hohlraums show excellent agreement.

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